Shared interest in a more productive tomorrow.

Alternative Timing, Frequency, Data, Positioning, and Navigation for NextGen: LFPhoenix™

Charles Schue – UrsaNav, Inc.

FAA Industry Day on NextGen APNT Initiative – May 3, 2012

Corporate Overview

Chesapeake, Virginia, USA

- **Founded in 2004**
- **Veteran Owned (VO) & Service Disabled Veteran Owned (SDVO) SB**
- **Strong engineering and IT background**
- **Extensive experience working under strict security and safeguard mandates**

Leesburg, Virginia, USA

- **Original Equipment Manufacturer (OEM) & Value-Added Reseller (VAR) Products**
- **Chesapeake, VA corporate headquarters includes a 22,000 SF office, light industrial, laboratory, and warehouse space**
- **Leesburg, VA facility includes 4,600 SF office and laboratory space**
- **Bertem, Belgium office handles EMEA opportunities**
- **Regional offices in Boston, MA and Charleston, SC**
- **Commercial and government clients in 32 countries.**

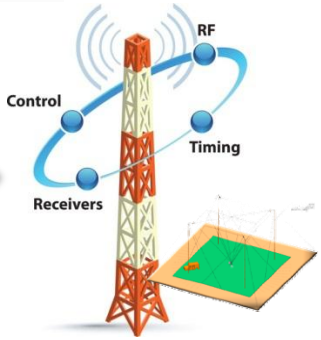
About us

Low-Frequency Business Unit

Alternative/Backup Solutions to GNSS/RNSS

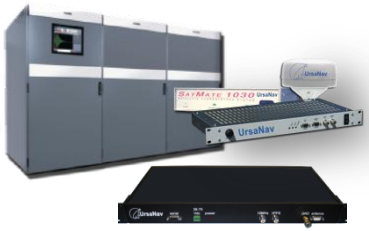
- Loran-C, Chayka, eLoran, LFPhoenix™, and Beyond
- Temporary, Transportable, & Tactical Solutions
- 21st Century Technology

Positions, Navigation, Timing/Frequency & Data (PNTF&D) Systems



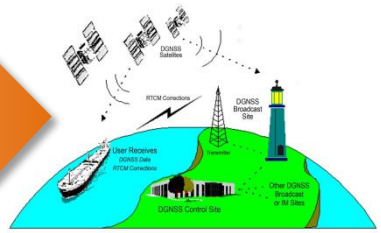
- Symmetricom Timing & Frequency Solutions
- TWLFTT, TWLLTT, TWSTT
- Transmit and Receive Antennae
- Data Channel (9th/10th Pulse, Eurofix, Other)

State-of-the-Art Transmitting & Receiver Technologies



- Nautel NL Series LF Transmitters
- UrsaNav LF Multi-Mode Receivers
- CrossRate, Locus, & Plutargus IP
- Receivers for UK GAARDIAN/Sentinel IDM

Differential GPS/GNSS Solutions



- Nautel Vector Series DGPS Transmitters
- Trimble RS/IM Equipment
- Trimble Control Station Software
- Antennas, Nautel ATU, spares, shelters
- Installation, training

Note: LFPhoenix is a currently a conceptual name

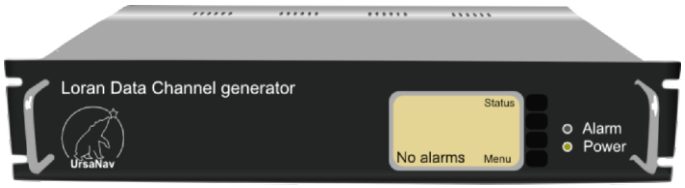
Why Does LFPhoenix™ Make Sense?

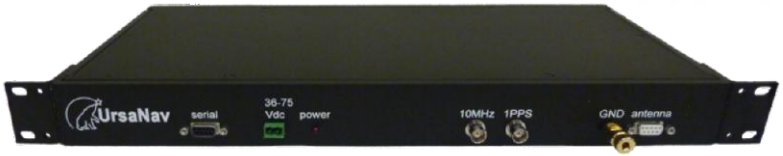
- Terrestrial-based
  - **Significantly** higher power than satellites
  - **Dissimilar failure modes** to GPS
- Considerable usable range of LF signals
  - Requires fewer transmitters than other terrestrial solutions
  - **Time, frequency, & data require only a single transmission site**
- 21st century technology: safe, efficient, cost effective
- **Spectrum protected** for safety-of-life service worldwide
- **Independent** of GPS, **but interoperab**le with GPS
- "P-Static" no longer an issue for aviation (H-field antenna)
- Signals are available indoors
- **Integrity built into LF signal**
  - Also provides complementary integrity for GPS
- Available **secure** signal encryption and geo-encryption
- Meets FAA RNP 0.3 accuracy, availability, integrity, continuity requirements

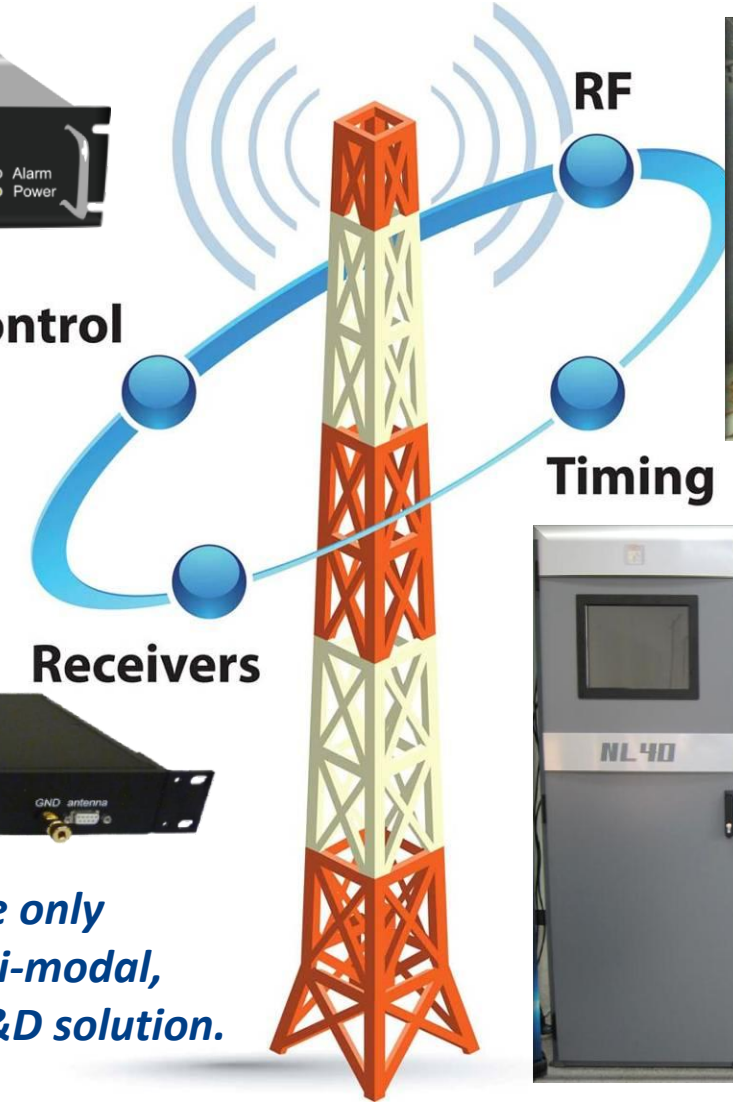
Why Does LFPhoenix™ Make Sense?

- Meets stringent **frequency** reference requirements
  - Provides **Stratum-1E** standard
    - Much better than 1 x 10^{-11} long-term
  - Same Stratum standard as GPS
- Meets stringent **timing** reference requirements (<1 us)
  - Transmissions synchronized to well within 10 ns of UTC
    - Sub nanosecond synchronization with Two-Way Time Transfer
  - Time recovery to within 75 ns RMS (UTC)
    - Distances to 500 miles (conservative; no differential corrections)
  - Time recovery to within 200 ns RMS (UTC)
    - At 1,000 miles (conservative; no differential corrections)
  - Monitoring & data channel corrections ensure precise time recovery
  - Provides "Assisted GPS" capability
- "High-speed" **data** channel(s) available (> 1,200 BPS)
  - All manner of functionality, including time of day and corrections
  - Offload VHF, or other, data requirements to improve system BW
  - Provides alternative wide-area critical messages/notifications
  - Third-Party Data Channel options

21st Century Technology







LF is currently the only homogeneous, multi-modal, very wide-area APNTF&D solution.

Global land-mass and EEZ+ coverage possible that is truly "sky-free".

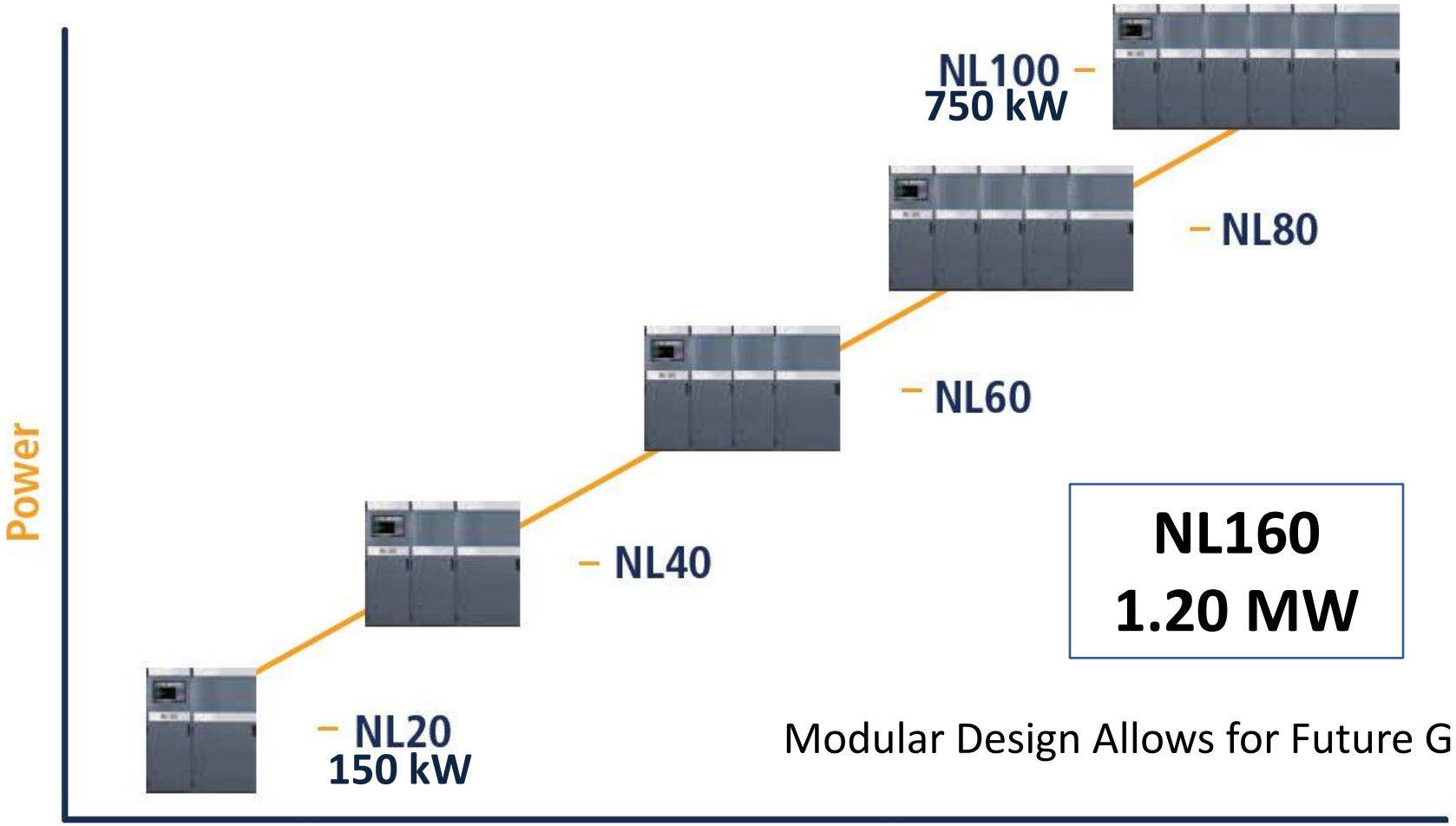
Transmitter Technology

- Patented power recovery technology
- Powerful, hot-swappable power amplifiers
- Fully redundant, self-healing
- Very high efficiency
- Very small footprint
- Very flexible

Nautel NL Series High-Power LF Transmitter

(6.0 ft H x 8.5 ft W x 3.3 ft D)

ERP into a 700-FT TLM Antenna



NL160
1.20 MW

Modular Design Allows for Future Growth

The NL Series naming convention is based on the total number of active modules in a given transmitter (ex. NL40 – 40 power modules)

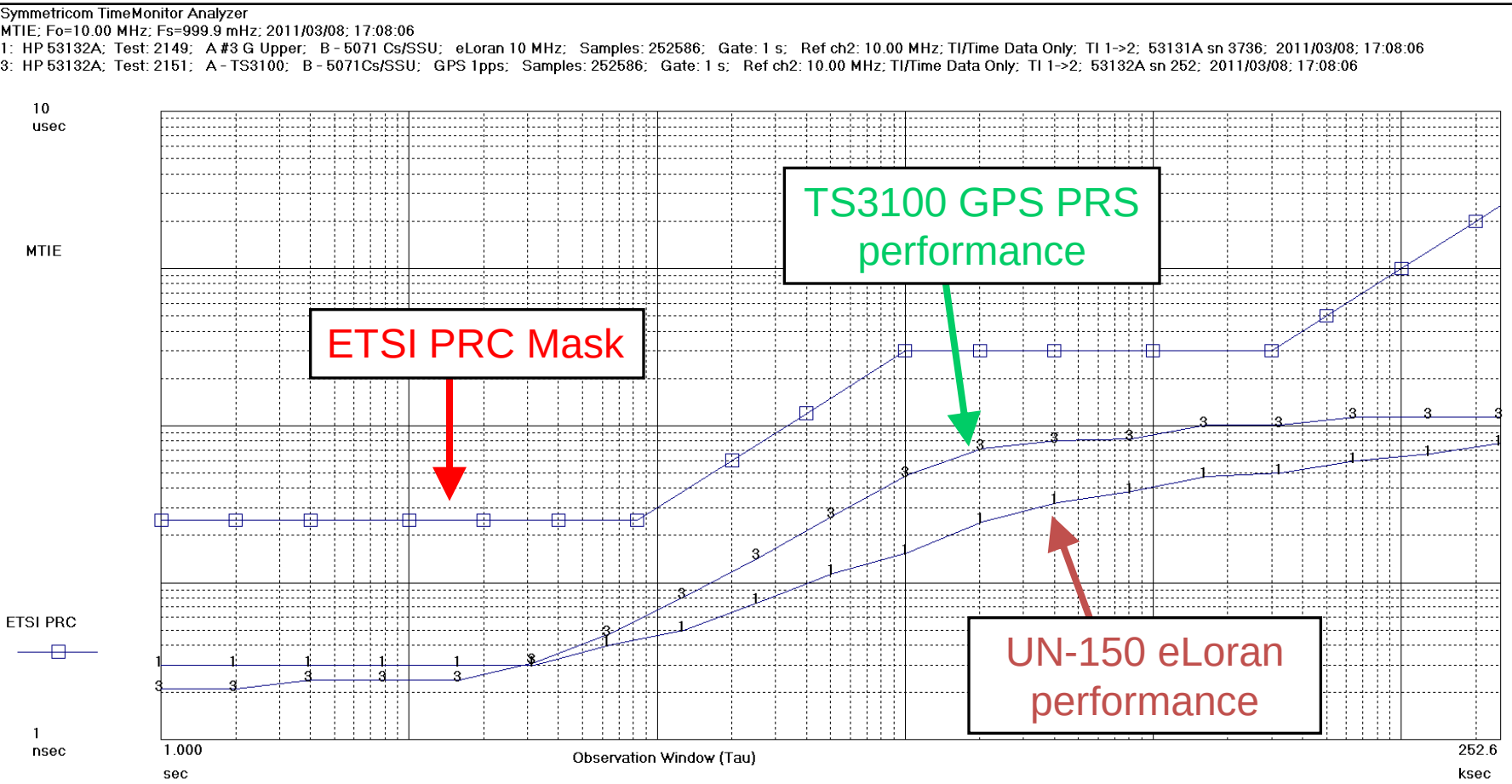
Current LF Receiver Technology

- UrsaNav acquired all Intellectual Property rights of **Locus** Inc., **Crossrate** LLC, and **Plutargus** – Combining IP to provide foundation technology for our new products

UrsaNav UN-150 eLoran Timing Receiver

- 10 MHz and 1PPS output aligned to UTC
- UN-150 eLoran timing receiver meets the stringent ETSI requirements for telecommunications Primary Reference Clocks
- Receiver maintains smooth timing through Loran or eLoran station un-availabilities (when multiple sites are available)

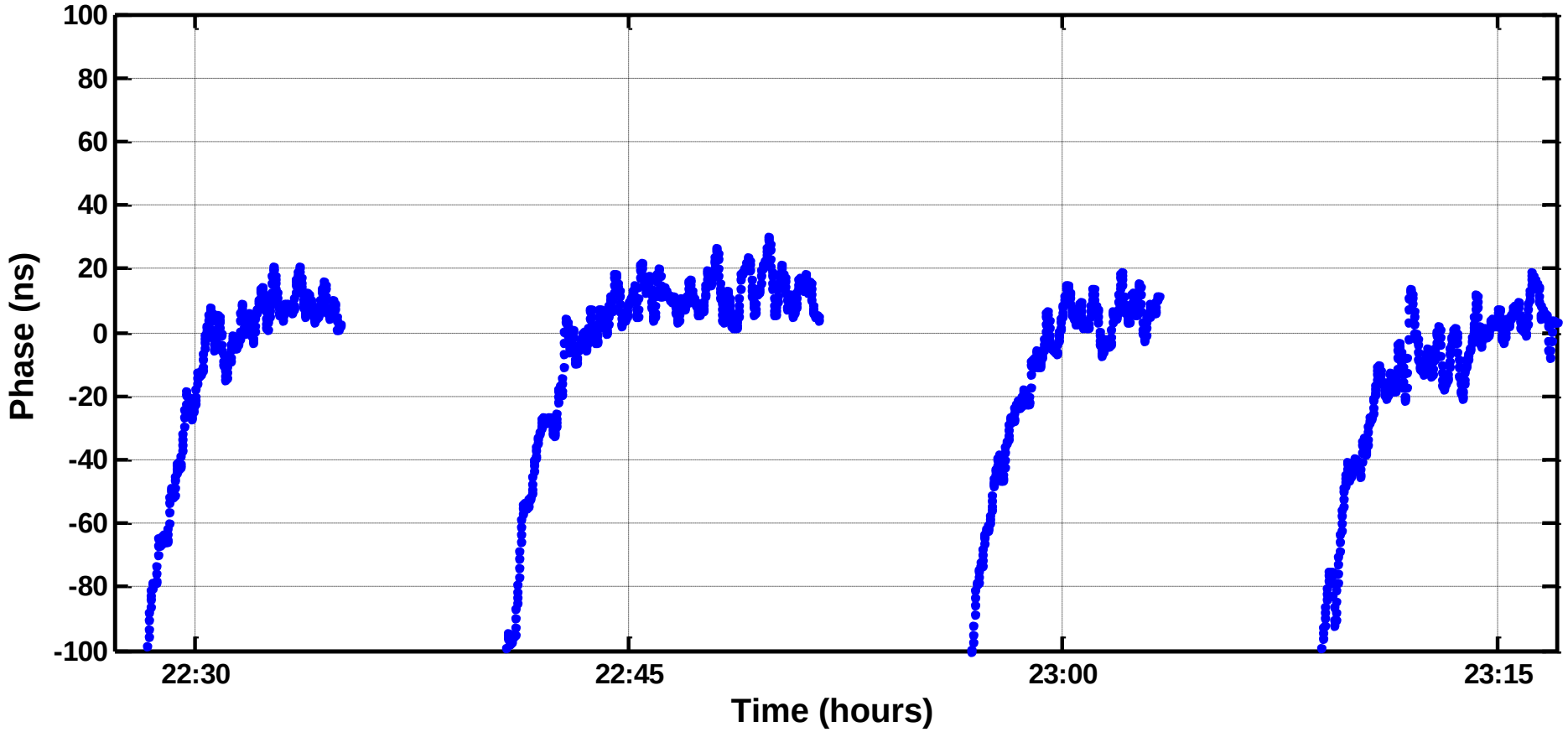
UN-150 Receiver MTIE Performance



Testing by Chronos Technology, Ltd.
and UK National Physical Laboratory

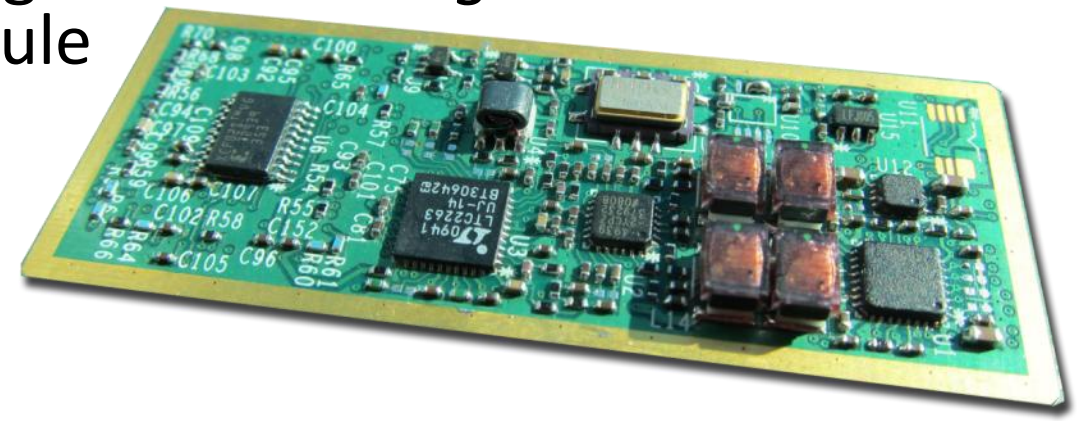
UN-150 Receiver Restart Performance

- UN-150 receiver consistently steered to UTC through intentional restarts



Ongoing Receiver Development

- Introducing the *Ursa Mitigator*™ UN-151 LF PNTF&D OEM Module



  - Robust, flexible, and affordable solution to meet wide range of PNTF&D receiver needs
  - Future-proofing for next generation LF & MF signals
  - Small form factor (currently credit-card size)
  - Software configurable
  - Complete range of integration capabilities
  - Onboard clock, and various external clock options (including CSAC)
  - Capable of processing multiple signals in the LF and MF bands
  - Provides improved platform for co-location with small form factor H-field receiving antenna technology

Availability of Signals Throughout USA

- September 2011 DHS report to Congress
  - GPS timing important
  - Concern for a lack of a backup(s)
- DHS investigating alternatives
  - Precise time via wire/fiber
  - Asked USCG to investigate wireless time transfer
- **CRADA (Effective 02/13/2012)**
  - Promotes R&D efforts; tech transfer
  - Not a contract; no exchange of funding; not government “sponsored”
- Objectives
  - Research, evaluate, document
- Disclaimer: USCG has no intent to acquire, operate, or provide a wireless time technology, or associated services

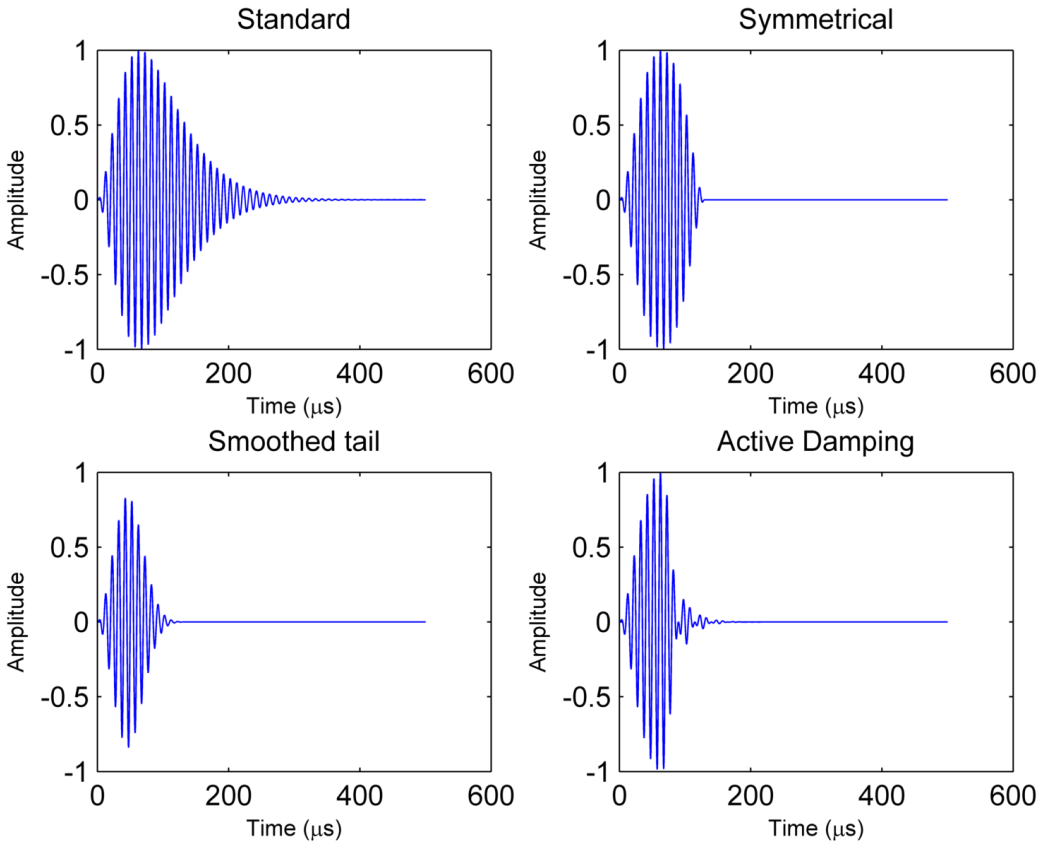
Initial Testing & Results

- Several weeks of testing in February, March, & April (so far)
- Transmissions from “dBF” Wildwood, NJ
  - Transmission to within 10 ns of UTC
  - Able to transmit from any former Loran-C or GWEN site
  - Able to transmit using transportable “LF-in-a-Box” solution
- Several test locations with multiple receivers
  - Leesburg, VA (142 miles)
  - Chambersburg, PA (160 miles)
  - Chesapeake, VA (170 miles)
  - Burlington, MA (310 miles)
  - University of New Hampshire (354 miles)
  - Charleston, SC (505 miles)
  - Mobile Measurement Unit

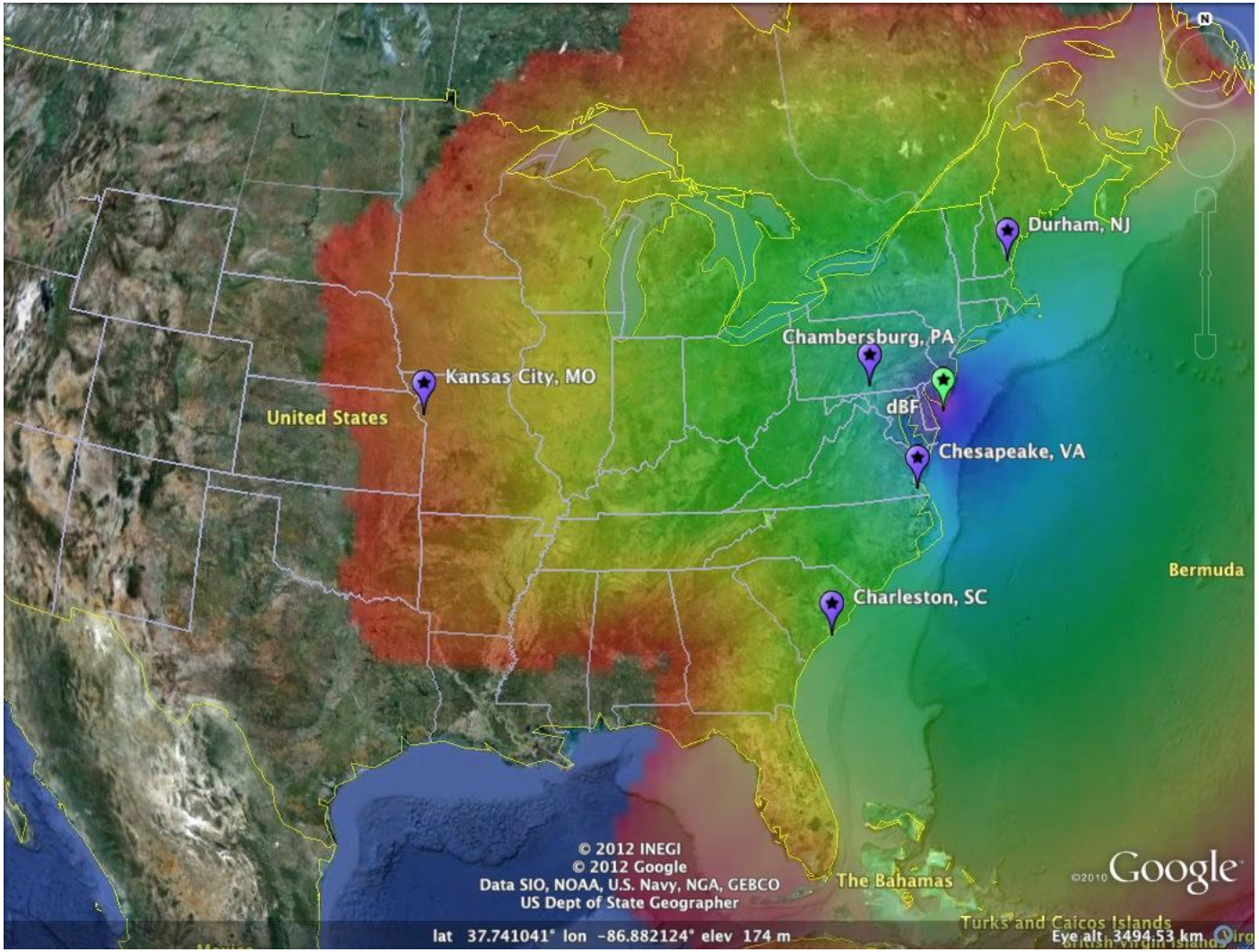
- TWSTT solution currently being installed at dBF
- TWLFTT solution – truly “sky-free” - available

Initial Testing & Results

- Improved phase codes
  - Phase codes should average to zero
  - Pseudo-Random Noise (PRN) based phase codes will allow unique identification of a station in a group and will reduce cross-correlation of signals from other stations
- Waveforms can be improved over traditional Loran/eLoran.
- Examples of actual on-air transmitted waveforms are shown here.
- Shorter pulses allow for more navigation pulses, or room for more data. Navigation function is not degraded.
- Improved crossrate effects.
- 4,000 PPS successfully tested.
- All tests performed on a 625' TLM using a Nautel NL 20 prototype transmitter.

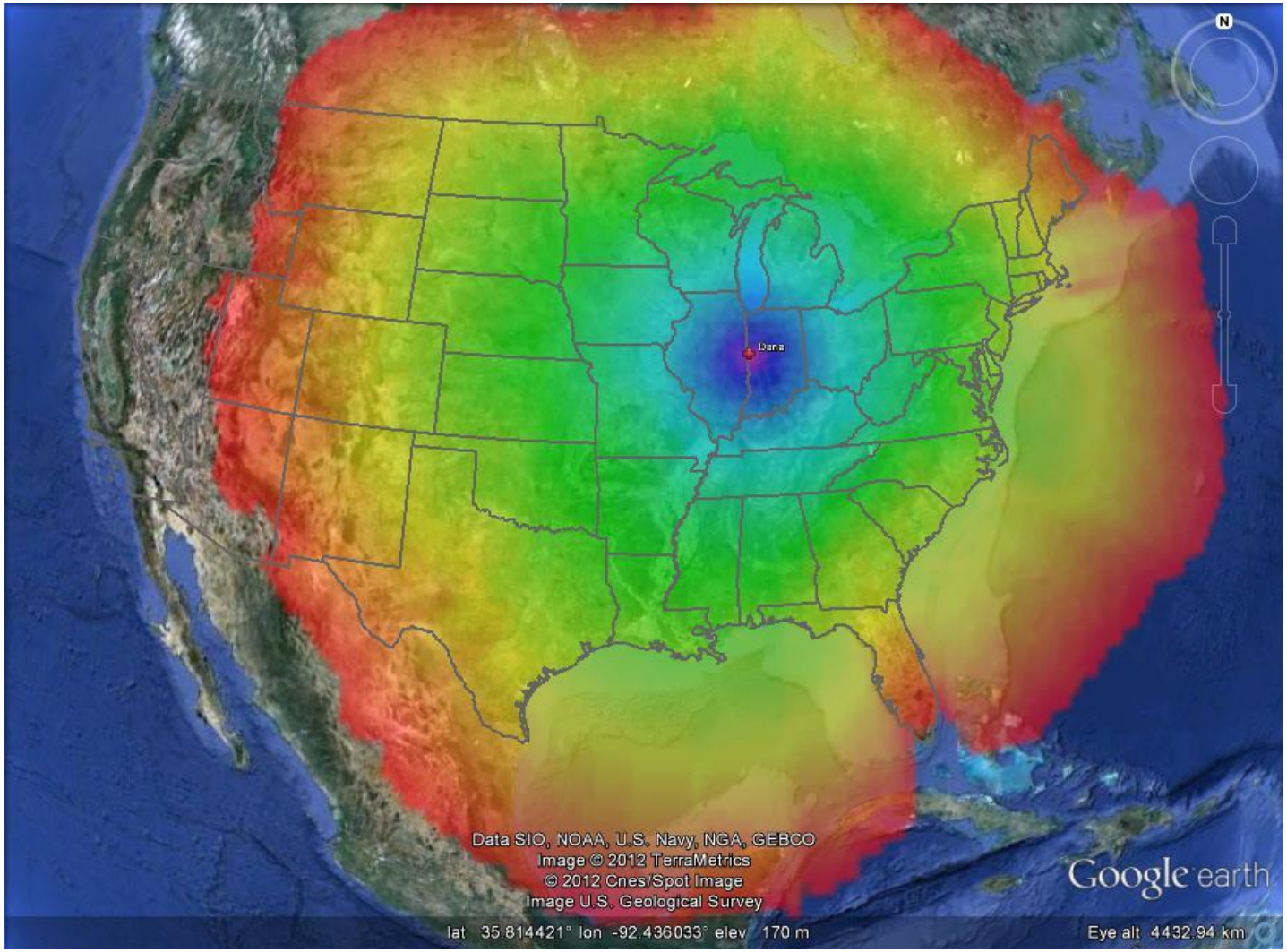


Verified T, F, & D Coverage



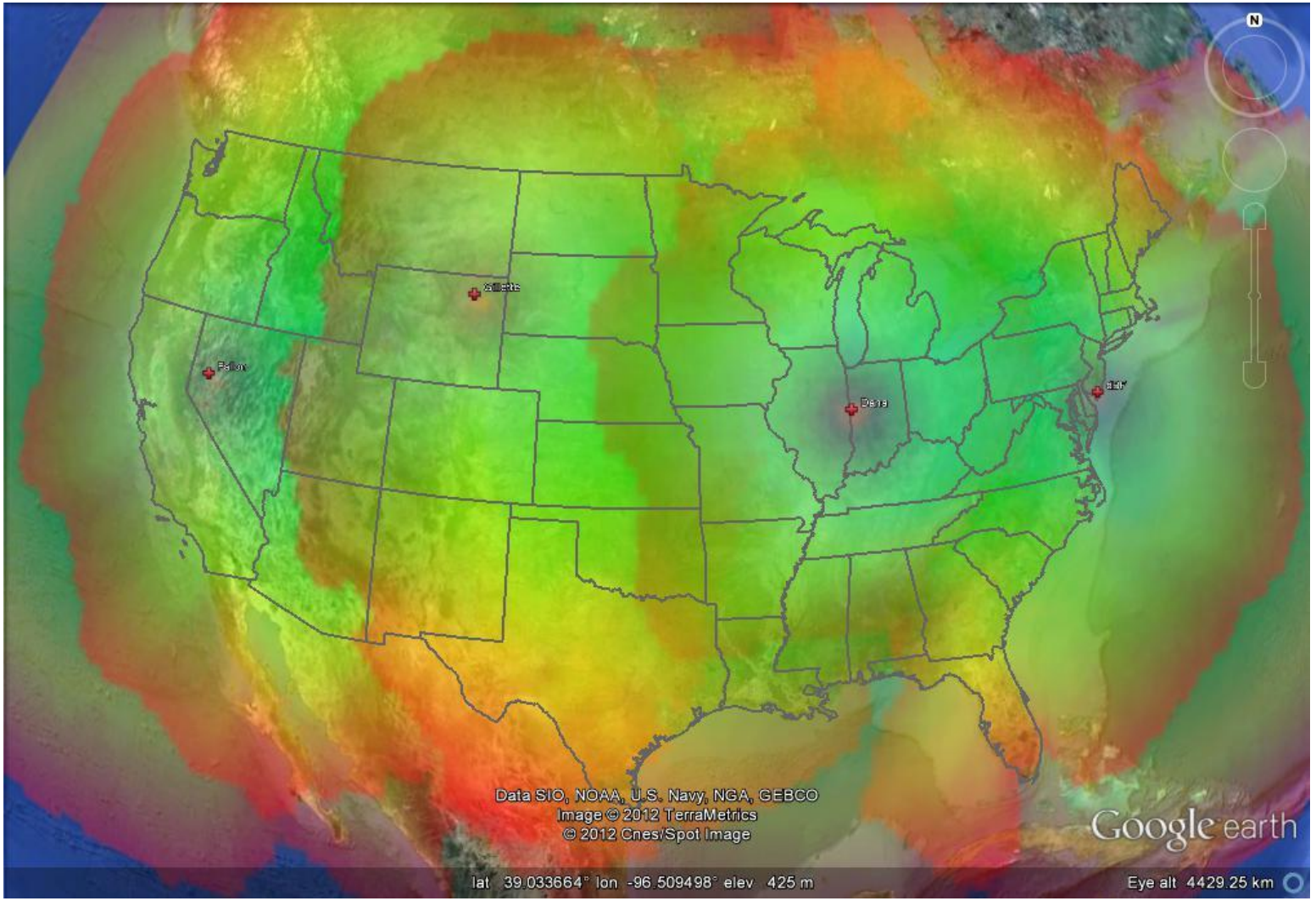
Proper reception, tracking, & decoding of signals from dBF at Kansas City, MO – 1,050 miles

Single Site Scenario: 1,000 Mile Radius



Wherever there is color, we expect LDC demodulation. With LDC comes precise time.

Multiple Site Scenario: 1,000 Mile Radius



Double+ T, F, & D Coverage Example for the Coterminous 48 States With Four Sites

Looking Ahead

- Investigate options for further improving transmission alignment to UTC
- Investigate variations in time, frequency, and data recovery because of changes in propagation and reception, and methods for compensating
- Continue to investigate the use of advanced waveforms for time, frequency, and data recovery
- Investigate signal reception, and time, frequency, and data recovery at greater distances
- Demonstrate time, frequency, and data signal recovery indoors
- Demonstrate performance as an input to other systems or solutions: DME, Pseudolite, GBAS
- ***Demonstrate ability to meet FAA time, frequency, data, and positioning requirements***

Benefits of LF APNTF&D to FAA: Today

- Terminated Loran-C is "Blue Ocean":
  - Nationwide test bed available today
  - Alternative waveform testing
  - Alternative modulation testing
  - Signal improvements/updates (phase code optimization) testing
  - Proximate to FAA research and test facilities (e.g., Atlantic City)
- Built-in, proven, and FAA-certified integrity
- Time, frequency, and data performance available today
- Technology available today
- Fulfills all CONOPS T&F requirements today

Benefits of LF APNTF&D to FAA: Tomorrow

- Time and frequency compatible with all current and proposed APNT solutions:
  - VOR
  - Optimized DME Network
  - Pseudolite
  - Passive Multi-Lateration
  - GEO (SBAS), MEO (GNSS+), LEO (Iridium)
  - Locata
  - TWSTT; Fiber-optic landline
- Nationwide alternative time-base using ensemble of three 5071A PRCs at each transmitting site
- Very low non-recurring & extremely low recurring costs
- Low cost receivers (especially as “sensors”)
- Better than double coverage available with four sites
- Sovereign solution, with no international obligations

LF. Time. Frequency. Data. Today!

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Backup: Contract Vehicles

GSA Contract Holder

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Grolar TECHNOLOGIES, LLC

- **Department of Homeland Security (DHS) Program Management, Administration, Clerical and Technical Services (PACTS)**
- **GSA Professional Engineering Services (PES)**
- **GSA Information Technology (IT) Schedule 70**
- **GSA Mission Oriented Business Integrated Services (MOBIS)**
- **<u>Electronic Federal Aviation Administration (FAA) Accelerated and Simplified Tasks (eFAST)</u>**
- **Navy Seaport-e**
- **Department of Veterans Affairs' Transformation Twenty-One Total Technology (VA T4)**
- **Navy SPAWAR Pillars (PII)**
- **Grolar Technologies JV**

Contracts

UrsaNav can help guide you to a successful contract relationship.

Experts you can trust to provide quality service.

ISO 9001
FM 540606

- **We are registered to the ISO 9001:2008 standard for the *provision of engineering and IT products and design of hardware and software products***
- **We are demonstrating SEI CMMI Level 2 and Level 3 capability across multiple projects for the Department of the Army, the Federal Aviation Administration, the Veterans Administration, and the Ohio University.**

Backup: Accolades

- Winner of **Virginia's Fantastic 50** for 2011. Awarded by Virginia Chamber of Commerce.
- Ranked **173rd fastest-growing company** (Government Services) in *Inc.* magazine's 500|5000 ranking for 2011. Ranked **1,906th fastest-growing company overall** in *Inc.* magazine's ranking for 2011.
- President and CEO Charles A. Schue received the **"Impressions in Print"** Leadership Award from the Hampton Roads Chamber of Commerce for 2010.
- Ranked **9th fastest-growing company** (Engineering) in *Inc.* magazine's 500|5000 ranking for 2010. Ranked **1,263rd fastest-growing company overall** in *Inc.* magazine's ranking for 2010.
- Ranked **8th fastest-growing company** (Engineering) in *Inc.* magazine's 500|5000 ranking for 2009. Ranked **807th fastest-growing company overall** in *Inc.* magazine's ranking for 2009.
- Named **"#1 Best Place to Work"** by *Inside Business* magazine (Medium-size Business category).
- Named one of the **"Top Ten Businesses to Watch"** by the Hampton Roads Chamber of Commerce.
- Received **"Best of Chesapeake Award"** (Engineers category) from the U.S. Commerce Association.
- Received the **"John C. Beukers Innovation Award"** from the International Loran Association.